Attorney Docket: **NCDL #10**

SYSTEM FOR ENHANCING PERFORMANCE OF AN INTERNAL COMBUSTION ENGINE

This application is based on and claims the benefit of U.S. Provisional Patent Application No. 60/423,732, filed on November 4, 2002.

TECHNICAL FIELD

This invention relates to a method and apparatus for enhancing the performance of an internal combustion engine, in particular the internal combustion engine of a vehicle.

BACKGROUND OF THE INVENTION

The use of an O_2 sensor to sense the amount of O_2 in the exhaust of an automobile or other motor vehicle and to send sensor signals to an electronic control unit or module (ECU) also incorporated in the motor vehicle is well known. The terms "electronic control unit", "module", "electronic control module" and "ECU" are interchangeable as employed herein. The ECU is associated with the fuel injector system of the engine to control the air/fuel mixture introduced into the engine cylinders. With the fuel system in closed loop operation after the O_2 sensor warms up, the O_2 sensor voltage cycles up and down. This cycling (which varies in speed between idling and cruising) occurs

because the ECU senses the O_2 voltage and then changes the pulse width of the signal driving the fuel injector on and off. This switching action allows the ECU to perform minor adjustments to the air/fuel ratio to allow the catalytic converter to perform its job to optimize the "oxidation" of carbon monoxide and hydrocarbons as well as the reduction of nitrogen oxides. The oxidation occurs when the mixture is slightly lean and more oxygen is available, and the reduction occurs when the mixture is slightly rich and less oxygen is available.

It is known to modify the function of an existing electronic control unit or module (ECU) by physically changing the functional parameters of the programmable eprom or computer chip, or changing the existing eprom itself inside the ECU, in an attempt to improve engine performance.

Various problems can arise when an existing ECU is modified as indicated above. The physically changed or new eprom must be specific to a manufacturer's application, and during use it may cause knocking, lean misfires, uncontrolled parameters during timed sequences and the signaling of alarming trouble codes in vehicles with on-board diagnostic (OBD) systems.

My U.S. Patent No. 6,260,547, issued July 17, 2001, discloses use of a controller interposed between an O_2 sensor and a preprogrammed electronic control unit employed in the motor vehicle to provide a richer fuel mixture than would normally be

the case and thus boost the performance of the engine.

The following United States patents and foreign patent documents are cited in U.S. Patent No. 6,260,547: U.S. Patent No. 5,836,153, issued November 17, 1998, U.S. Patent No. 5,777,204, issued July 7, 1998, U.S. Patent No. 4,479,464, issued October 30, 1984, U.S. Patent No. 4,202,301, issued May 13, 1980, U.S. Patent No. 5,033,438, issued July 23, 1991, U.S. Patent No. 5,251,604, issued October 12, 1993, British Patent No. 2,077,962, dated 12/1981 and British Patent No. 2,093,228, Granted August, 1982.

The invention disclosed in my U.S. Patent No. 6,260,547 alters the O_2 sensor signal voltage to the ECU. The ECU responds to this altered signal by widening the pulse width to the injectors thereby enriching the air/fuel ratio during the combustion process. The ECU has a fuel map which has pre-determined fuel values which are influenced by factors such as RPM, manifold absolute pressure (MAP), engine temperature, intake air temperature, and throttle position. These fluctuating parameters or variable operational factors relating to the operation of the internal combustion engine influence the points on the map that the ECU uses to send out a predetermined electrical pulse width to open the fuel injectors which is then fine tuned by the corrective signal from the O_2 sensor to a pre-set air/fuel ratio.

In the arrangement disclosed in U.S. Patent No. 6,260,547, the O_2 sensor signal is altered a specific or pre-set percentage (depending on the enrichment setting used) throughout the entire ECU fuel map without adjusting for fluctuating manifold absolute pressure or other of the above-indicated influences. As a result, the percentage of enrichment by current technology remains fixed whether the ECU map is influenced by additional parameters as stated above or not. Because these additional variable operational factors relating to the operation of the internal combustion engine continuously change and influence the ECU's fuel map when responding to the O_2 sensor signal, a minor fluctuation occurs in the specific air/fuel ratio as pre-set.

DISCLOSURE OF INVENTION

In order to precisely maintain an optimum or specific air/fuel ratio, the invention disclosed and claimed herein provides for the adjustment of the percentage of enrichment to synchronize with the above-described additional influencing parameters, as well as possibly others. The invention allows a more varied and precisely controlled air/fuel ratio throughout the entire operational range of the ECU and during varying loads and engine speeds.

The apparatus of the invention is for improving the performance of the internal combustion engine of a motor vehicle

having fuel injectors. The invention incorporates basic closed loop control but utilizes the O_2 sensor voltage to adjust selected sensors before being sent to the electronic control unit. The ECU senses the altered sensor voltages and changes the enrichment rate according to specified programmed look up tables (MAP). The apparatus includes an O_2 sensor for sensing the amount of O_2 in exhaust produced by the internal combustion engine, at least one supplemental sensor for sensing a variable operational factor relating to the operation of the internal combustion engine, and a programmed electronic control unit for receiving O_2 sensor signals from the O_2 sensor.

The apparatus further includes a controller for receiving and altering the O_2 sensor signals from the O_2 sensor prior to the O_2 sensor signals being received by the electronic control unit. The at least one supplemental sensor is directly operatively connected to the controller and sends supplemental sensor signals to the controller. The controller adjusts the supplemental sensor signals and sends the adjusted supplemental sensor signals to the electronic control unit. The electronic control unit, in response to receipt of the altered O_2 sensor signals and the adjusted supplemental sensor signals produces modified fuel injector control signals controlling operation of said fuel injectors.

The invention also encompasses a method.

Other features, advantages and objects of the present invention will become apparent with reference to the following description and accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a diagrammatic representation illustrating an internal combustion engine and exhaust system having an O_2 sensor, a plurality of supplemental sensors, an ECU and a controller for altering O_2 sensor signals and supplemental sensor signals;

Fig. 2 depicts a representative ECU fuel map graphically illustrating air/fuel ratios at different RPMs for an internal combustion engine not incorporating the present invention and an internal combustion engine incorporating the invention; and

Fig. 3 is a detailed circuit diagram of a controller for carrying out the teachings of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Fig. 1 illustrates a conventional motor vehicle internal combustion engine 10 having fuel injectors 12. An exhaust pipe 14 extends from the engine 12, a catalytic converter 16 and a muffler 18 being operatively associated with the exhaust pipe in a conventional fashion.

An O_2 sensor (also known as a lamda sensor) 20 of conventional construction is employed for sensing the amount of O_2 in the exhaust passing through exhaust pipe 14. Also, as is conventional, an electronic control unit or module (ECU) 22 is operatively associated with fuel injectors 12, the electronic control unit being pre-programmed and receiving sensor signals from O_2 sensor 20.

In response to the sensor signals, the electronic control unit produces fuel injector control signals controlling operation of the fuel injectors, in accordance with the pre-programming of the electronic control unit.

As described in more detail in my U.S. Patent No. 6,260,547, the fuel injectors operate in a pulsed manner, the air/fuel pulses resulting from the associated electronic control unit having a wave form. The upper and lower portions of the normal wave form are substantially of the same magnitude and respectively in a rich zone and a lean zone on opposed sides of a pre-determined stoichiometric line representing a set stoichiometric air/fuel mixture. That is, in a conventional arrangement the pulse portions fall generally evenly in the rich and lean zones so that the desired overall average stoichiometric value is attained or closely approximated. The preset programming of the electronic control unit may not be such as to optimize the operation of the internal combustion engine with

which the electronic control unit is associated, and in accordance with the invention of my U.S. Patent No. 6,260,547, a controller is interposed between the O_2 sensor and the pre-programmed electronic control unit to modify the sensor signals from the O_2 sensor to produce modified sensor signals.

These modified sensor signals are transmitted from the controller to the electronic control unit and result in the electronic control unit generating modified fuel injector control signals. These modified fuel injector control signals cause the fuel injectors to provide a richer fuel mixture to the internal combustion engine over a period of time than would be provided in the absence of the step of modifying the sensor signals from the O_2 sensor.

The apparatus of the present invention also utilizes a controller interposed between the O_2 sensor and the programmed electronic control unit. The controller is identified by reference numeral 30. Fig. 3 illustrates circuitry and components of a form of controller 30 which may be employed in the present invention. As is the case with the controller disclosed in my U.S. Patent No 6,260,547, the controller 30 also serves to receive O_2 sensor signals from the O_2 sensor and alters the O_2 sensor signals prior to the O_2 sensor signals being received by the electronic control unit. The electronic control unit responds to this altered signal by widening the pulse width

to the injectors thereby enriching the air/fuel ratio during the combustion process, as described in my afore-referenced patent.

The electronic control unit has a fuel map, a representative form of which is shown in Fig. 2. The fuel map has pre-determined fuel values which are influenced by factors such as RPM, manifold absolute pressure (MAP), engine temperature, intake air temperature and throttle position. These fluctuating parameters or variable operational factors relating to the operation of the internal combustion engine influence the points on the map that the electronic control unit uses to send out a pre-determined electrical pulse width to open the fuel injectors as having been fine tuned by the corrective signal from the O_2 sensor to a pre-set air/fuel ratio.

A limitation in the technology disclosed in U.S. Patent No. 6,260,547 exists in that the technology alters the O_2 sensor signal voltage a specific or pre-set percentage (depending on the enrichment setting used) throughout the entire ECU fuel map without adjusting for fluctuating manifold absolute pressure or the other above-indicated influences. As a result, the percentage of enrichment will remain fixed whether the ECU map is influenced by the additional above-stated variable operational factors or not. Because these additional influencing parameters constantly change and influence the ECU's fuel map when responding to the O_2 sensor signal, a minor fluctuation occurs in

the specific air/fuel ratio as pre-set. In order to precisely maintain an optimum or specific air/fuel ratio, the invention disclosed and claimed herein adjusts its percentage of enrichment to synchronize with these additional influencing parameters.

Referring to Fig. 1, these fluctuating or variable operational factors relating to the operation of the internal combustion engine 10 are generated by supplemental sensors, in this arrangement manifold absolute pressure sensor 40, engine temperature sensor 42, throttle position sensor 44, intake air temperature sensor 46, mass air flow sensor 48 and RPM sensor 50.

The supplemental sensor signals received from supplemental sensors 40, 42, 44, 46, 48, 50 are directly received by controller 30. The controller 30 selectively alters the supplemental sensor signals prior to the supplemental sensor signals being received by the electronic control unit 22. A switch 60 may be associated with the controller 30 so that an operator can turn the controller on or off manually. If turned off, the O_2 sensor signals and the supplemental sensor signals can pass straight through to the electronic control unit.

The apparatus incorporates basic closed loop control but utilizes the O_2 sensor both as a corrective and driving device which monitors O_2 sensor voltage to adjust selected supplemental sensor signals before being passed on to the electronic control unit. The ECU senses the altered supplemental

sensor voltages created by the controller and changes the enrichment rate according to specified programmed look up tables (MAP). These controlled sensors include, but are not necessarily limited to, supplemental sensors 40, 42, 44, 46, 48, 50. The new areas of the look up tables due to modified sensor output affect the length of time that voltage is sent to the injectors 12 (pulse width) for a varied fuel amount delivery to attain the desired air fuel ratio.

This system of control provides infinite voltage control of the above-referenced sensors so that optimum air/fuel ratios can be precisely maintained under all driving and load conditions and throughout the entire operational range of the ECU.

The representative fuel map shown in Fig. 2 illustrates how the present invention can be utilized to attain an optimum air/fuel ratio. The graph designated by the letter A is representative of that produced by a motor vehicle internal combustion engine without use of the present invention but employing that of my U.S. Patent No. 6,260,547. The graph designated by reference letter B is produced by a motor vehicle internal combustion engine utilizing the teachings of the present invention.